Validation of sea ice parameteres by AMSR/AMSR-E in the Sea of Okhotsk and Antarctic sea

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AASI WS, NASA/GSFC, Jan. 13-14, 2005

Validation Schedule (ADEOS2/AMSR&Aqua/AMSR • E: Sea Ice) -Post lauching-

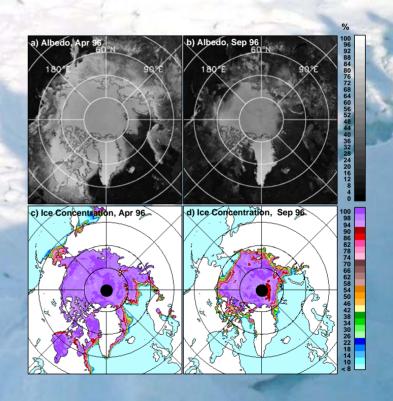
	Okhotsk Sea	Antarctic Ocean & Continent
2002	ADEOS2 launching (Dec.14) , Aqua/AMSR-E(May 5) Okhotsk Sea Field experiments(February~March) Aircraft(AMR, VTR, etc.), Icebreaker, field campaign Okhotsk Sea Field experiments(February~March) Aircraft(AMR, VTR, etc.), NASA/P3 Icebreaker, field campaign	ADEOS2 launching New Glaciological Program(JARE) 5-year term Wintering at Showa St. (GLI Receiving) Antarctic Campaign-AASI (August~September, NASA) Punta Arenas Weddell Sea & Belingshausen (P3, Icebreaker) Australian icebreaker(OctNov.)
2004	Okhotsk Sea Field experiments(February~March) Aircraft-PiSAR Icebreaker, field campaign	Antarctic Campaign-AASI (October, NASA) –P3 Ushuaia Ross Sea (P3, Icebreaker) Study on sea ice & snow cover on ice sheet(AMSR & GLI) by JARE(Wintering)
2005	Okhotsk Sea Field experiments (February~March) Aircraft-PiSAR Icebreaker, Field campaign	Antarctic Campaign (JARE) winter(August~October,) near Syowa St. & Ice sheet to inland
2006	Okhotsk Sea Field experiments(February~March)	Antarctic Campaign (NASDA & JARE) winter(August~October, DC8) near Syowa St. & Ice sheet to inland
2007	Okhotsk Sea Field experiments(February~March)	IGY/IPY memorial year

Scientific Motivations:

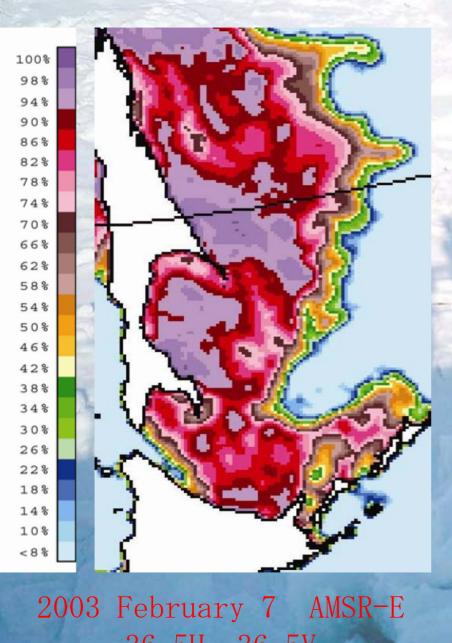
- The polar regions may provide the earliest signal of a climate change because of feedbacks between ice, ocean and atmosphere.
- 1. The Okhotsk sea (SH) is the southern-most ocean covere with sea ice in the winter and also provide the earliest signal of a climate change.
- Sea ice concentration and ice thickness.
- The Antarctic Peninsula region is observed to be anomalously warm compared to the rest of the continent.
- The entire Antarctic sea ice cover has been observed to b increasing at less than 1%/decade while the Bellingshausen/Amundsen Seas region has been declinin at about 6%/decade.
- Correlation of SO indices (or El Niño) with B/A ice cove

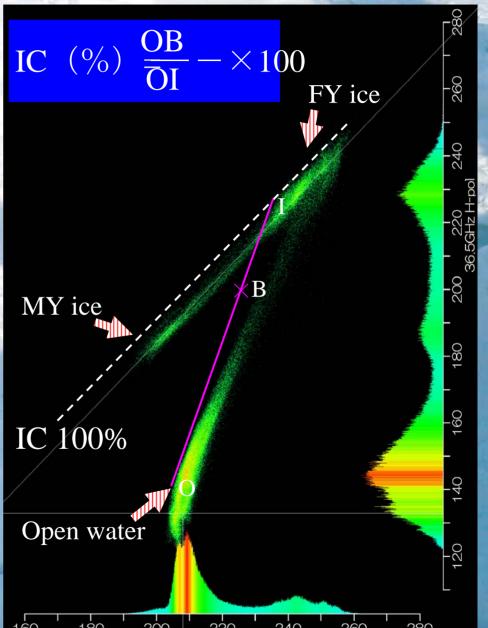
Sea Ice Cover in the NH using visible and passive microwave data

- The passive microwave and visible data provide complementary information.
- Both data provides useful and consistent surface information.



Sea ice concentration (Bootstrap)





Validation Strategy

- Aircraft Validation Campaigns
 Sea of Okhotsk Mission February 2003
 AASI Campaign August September 2003*
 AASI Campaign October 2004
 PiSAR February 2004 & 05
- High Resolution Satellite Data MODIS, GLI** Landsat Quickbird/IKONOS
- Ship Data/other in situ data
- Radiative Transfer Modeling

Validation Tools (2003 & 04))

• P3 Aircraft – coordinate with Aqua & ADEOS2 orbit

PSR A & C – Sensor calibration and parameter studies

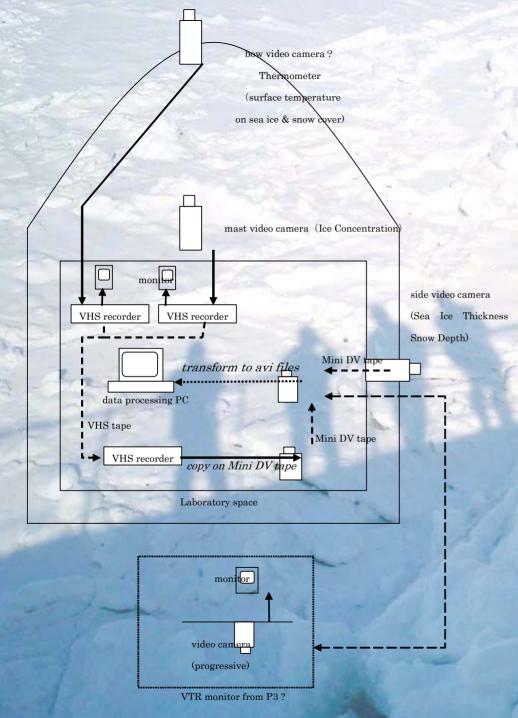
ATM – ice thickness and topography studies

THOR – snow thickness and cloud cover studies

D2P – ice and snow thickness studies

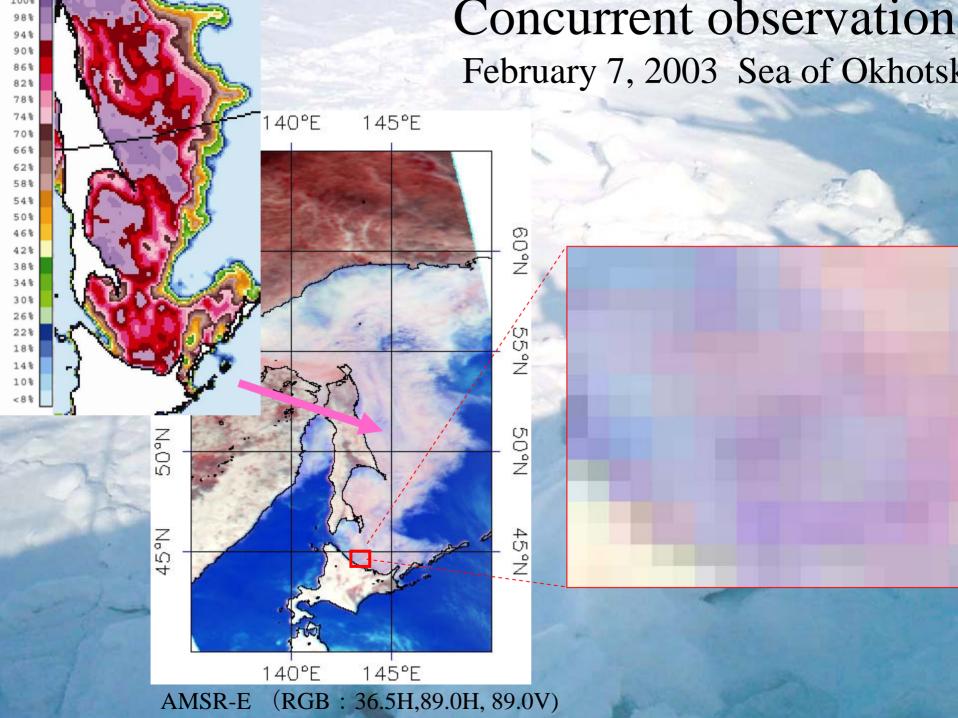
TAMMS – heat and humidity flux studies

- Ship Observations- in situ data of passive microwave observations and physical characterization of the ice
- High Resolution Satellite Observations <u>Landsat</u>, ASTER, Ikonos
- PiSAR(2004 & 2005)
- Radiative Transfer Modeling Studies

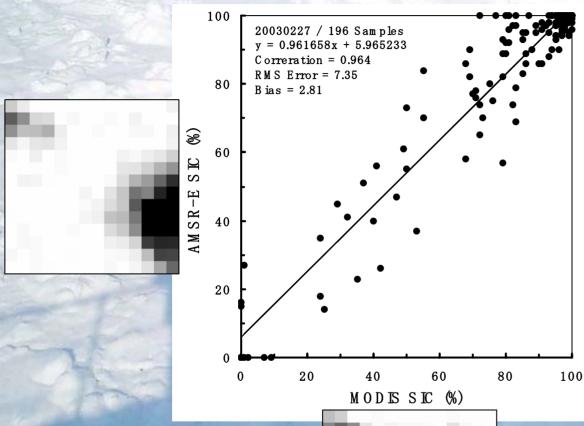


Ship measurements

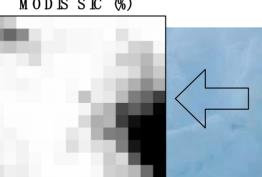
- 1) ice concentration
- 2) sea ice thickness
- 3) snow depth
- 4) sea ice classification (by VTR, IR-VTR, digital camera)
- 5) Sea surface temperature (thermometer)

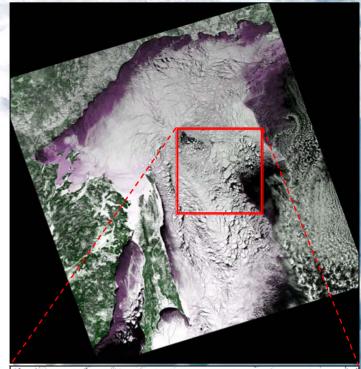


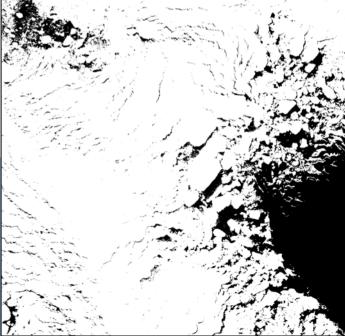
Validation using MODIS



February 27, 2003 Sea of Okhotsk

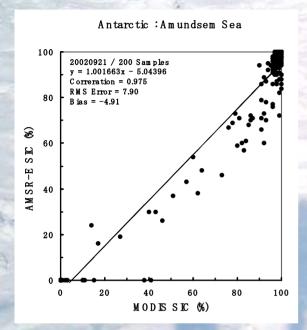






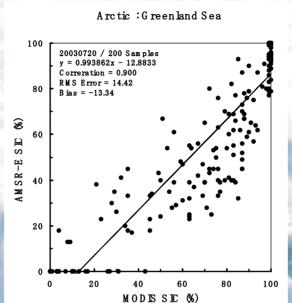
MODIS - AMSR/E

Antarctic sea

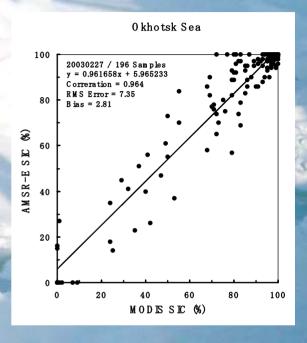


Arctic sea

sea

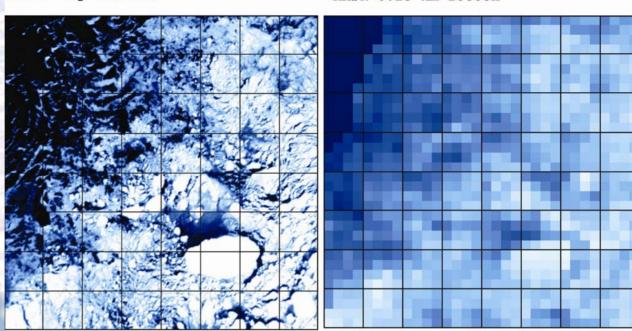


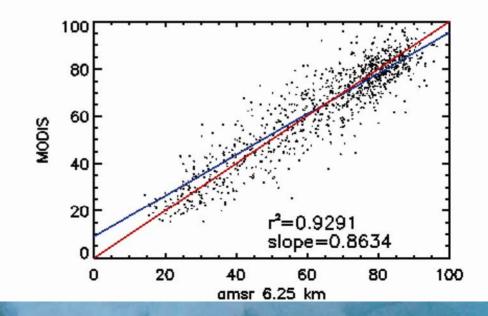
Okhotsk



- Correctation >
- 10.39% (Antarctic: 7.90, Arctic: 14.42, RMS error Okhotsk: 7.35)
- -5.20% (Antarctic:-4.91, Arctic:-13.34, Bias Okhotsk: 2.81)
 - +Bias in Okhotsk Sea

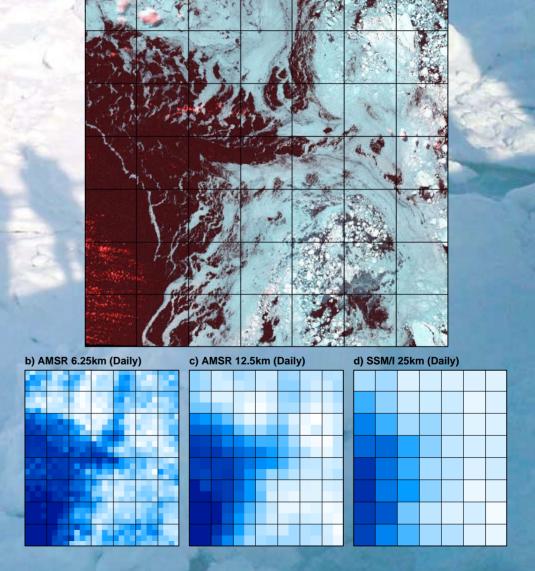
Modis and **AMSR-E** at 6 km grid shows basically the same general features of the ice cover. They are also highly correlated.





AMSR-E versus Landsat

- Landsat data provide information that can be very useful in the interpretation of AMSR-E data
- The concentration of new ice depends on thickness and stage of growth.



February 11, 2003

a) Landsat

Summary (sea ice concentration)

- High resolution AMSR data are shown to be consistent with MODIS and Landsat data and can be useful for mesoscale studies when atmospheric effects are not critical.
- Aircraft data are very useful especially in sorting out effects of various components of the ice pack.
- AMSR/AMSR-E is an excellent successor to SSM/I

Aircraft and ship observation

- February 5 14, 2003.
 - Sea of Okhotsk
- August 16 September 4, 2003.
 - Bellingshausen Sea
- September 11 October 30, 2003.
 - Hobart to Casey station (AUS)
- February 5 14, 2004.





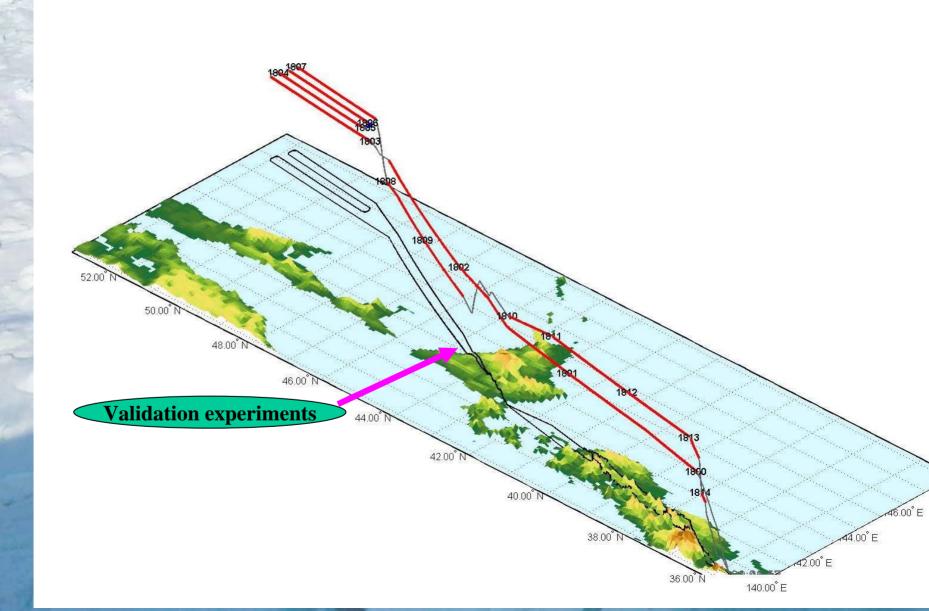




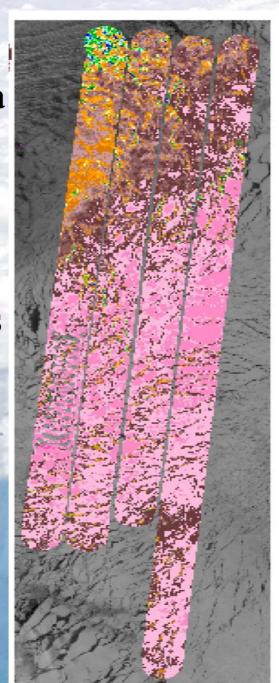


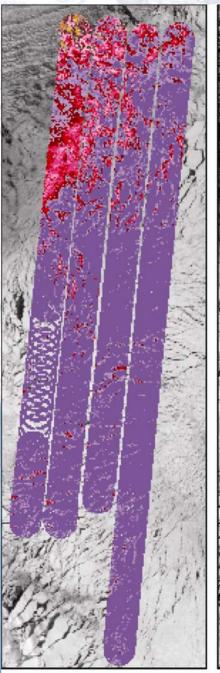






PSR-A T_B data at 37 GHz (H) and derived ice concentrations **Overlayed** on **MODIS** data

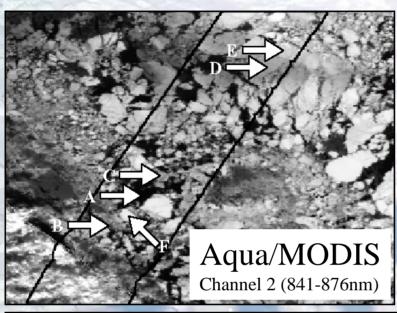


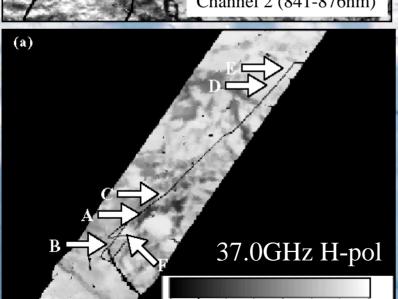




PSR+MODIS

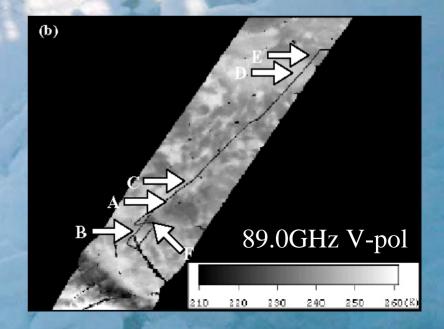
PSR data over P/V "SOYA"





140 160 180 200 220 240 26D(8



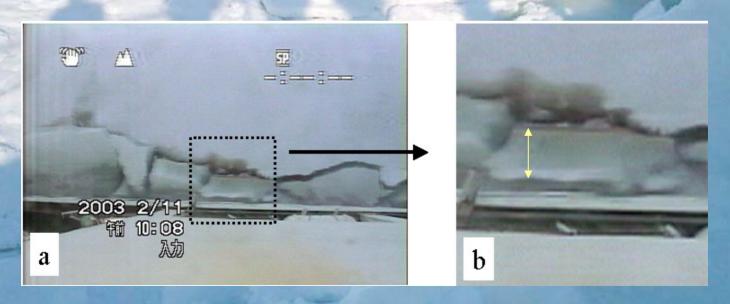


Sea ice thickness observation from ship



Position of camcorder on P/V SOYA

Sample images taken by camcorders a:mast, b:bow, c:broadside

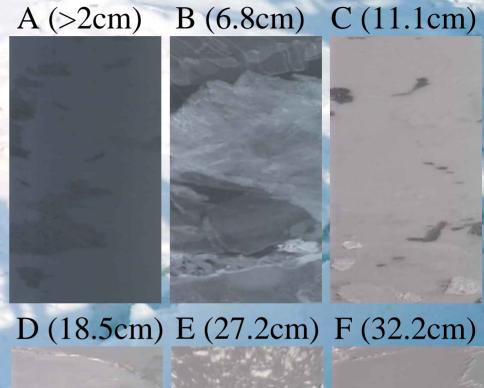


Example image of measuring sea ice thickness

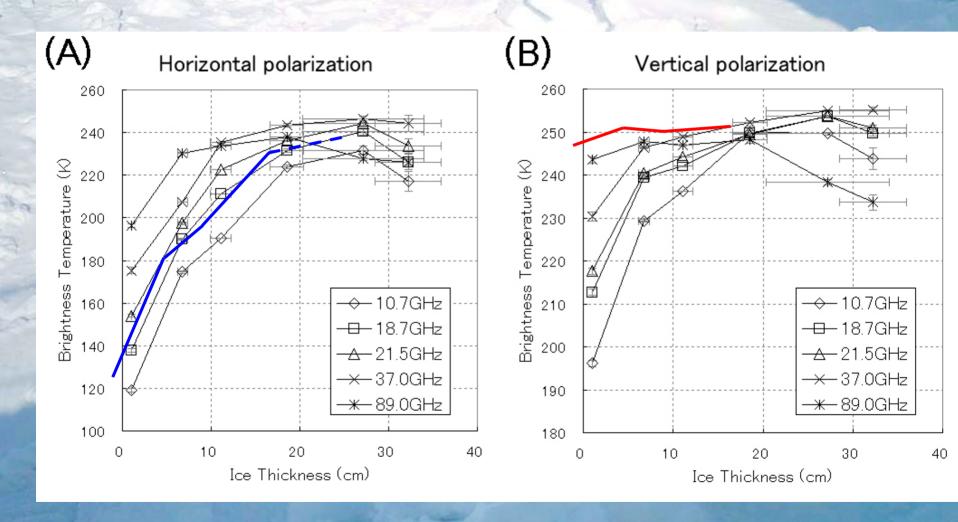
Average sea ice thickness of area "A" ~ "F"



Aqua/MODIS Channel 2 (841-876nm)



Relationship of brightness temperature to sea ice thickness



Sea Ice Thickness Observation in the Sea of Okhotsk by using Dual-Frequency and Fully Polarimetric Airborne SAR (Pi-SAR Data

Pi-SAR (Polarimetric interferometric

SAR)

- Pi-SAR feature
 - Dual frequency, full polarimetry, cross-track interferometry
- Data processing

 Speckle noise reduction (5x5 moving average filtering), Sigma-0 correction, and map

projection

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Service of the servic	X-Band Main Antenna
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Platform	Gulfstream-II		
Radar frequency	9.6 GHz (X-band)	1.27 GHz (L-band)	
Radar wavelength	3.14 cm	23.6 cm	
Range resolution	1.5 m, 3.0 m	3.0 m, 5.0 m, 10.0 m, 20.0	
Azimuth resolution	1.5 m, 3.0 m	3.0 m, 6.0 m	
Number of looks	4		
Antenna Size	105 cm (L) x 19 cm (W)	155 cm (L) x 65 cm (W)	
Antenna Type	Slotted waveguide array	Microstrip patch array	
Swath width	9.4 km, 20.4 km (polarimetry) 5.6 km, 12.9 km (polarimetry and interferometry)	42.9 km (single polarization 20.4 km (polarimetry)	
Incidence angle	10° - 75°	20° - 60°	
Cross-track interferometry	Available (Height accuracy 2.0 m)	N/A	

Pi-SAR/L-band images

- 2004.2.9
 - HH/HV/VV were assigned to RGB with histogram correction.
 - Incidence angle is 45 degrees at scene center.



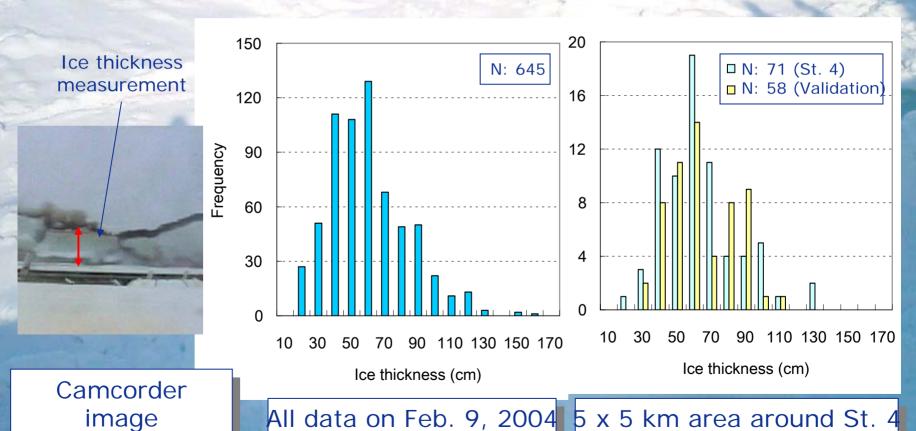
East shore of lake for ice Anchored observation classification validation

site 4 (St.4)

5 km north from St. 4 for Ice thickness validation

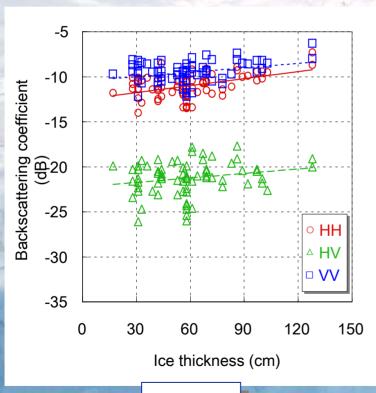
Ice thickness distribution

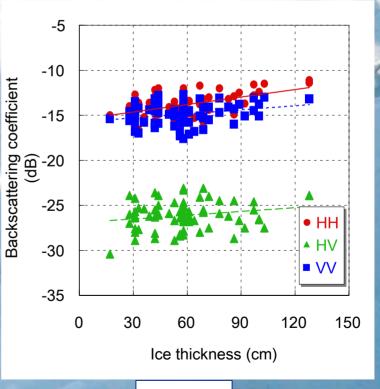
- Frequency of ice thickness in the Sea of Okhotsk.
 - Ice thickness was measured by analyzing images of sea ice taken by a camcorder after it broke up with. GPS eas used for position.



and backscattering coefficient

- The backscattering coefficient increased as ice thickness increased.
 - Derived from around St.4, 5 x 5 km in the Sea of Okhotsk.
 - Incidence angle of 45° at the scene center.





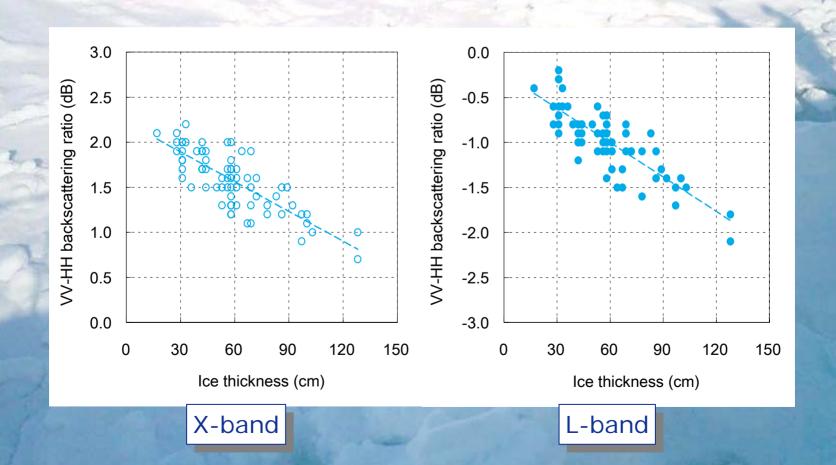
X-band

L-band

*** * * * * * ***

Relationship between ice thickness and backscattering ratio (VV/HH)

- The backscattering ratio decreased as ice thickness increased.
 - Derived from around St.4, 5 x 5 km in the Sea of Okhotsk.

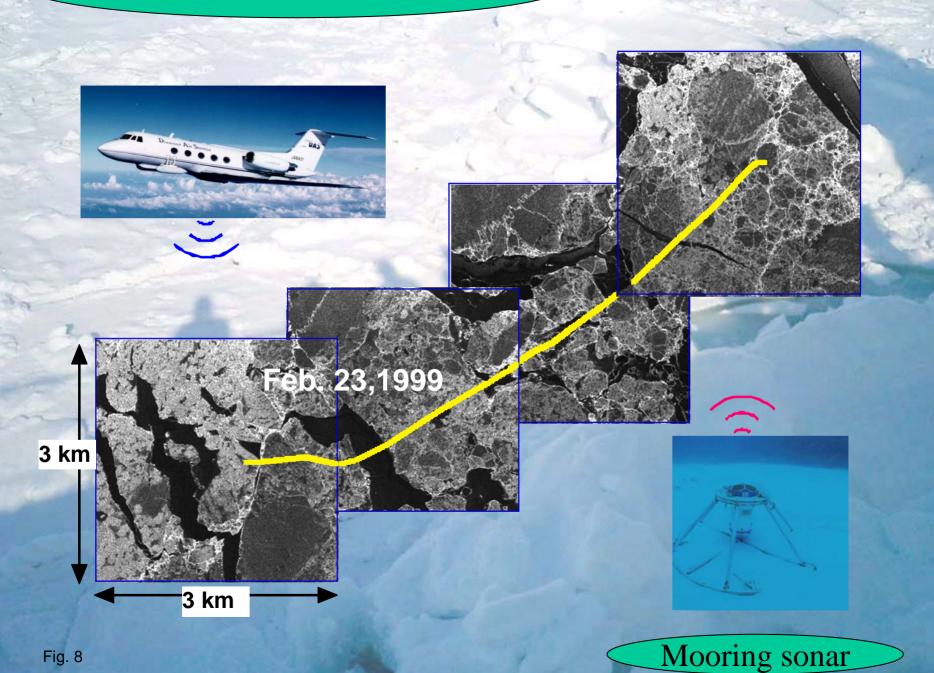


Summary

- Relationship between ice thickness and backscattering coefficient:
 - Backscattering coefficients increased as the ice thickness increased for all frequencies and polarizations.
- Sea ice physical parameters retrieval
 - Classification of ice types
 - Polarimetry decomposition can be used as a detection methodology for classifying thin ice as NI and YI-FYI.
 - This classification of ice types was applicable to L-band SAR data.
 - Ice thickness
 - It was possible to estimate the thickness of YI and FYI using VV-HH backscattering ratio.
 - -> Estimation of ice thickness was possible using bot X-band and L-band SAR data.

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PiSAR Validation 1 9 9 9 Feb.23



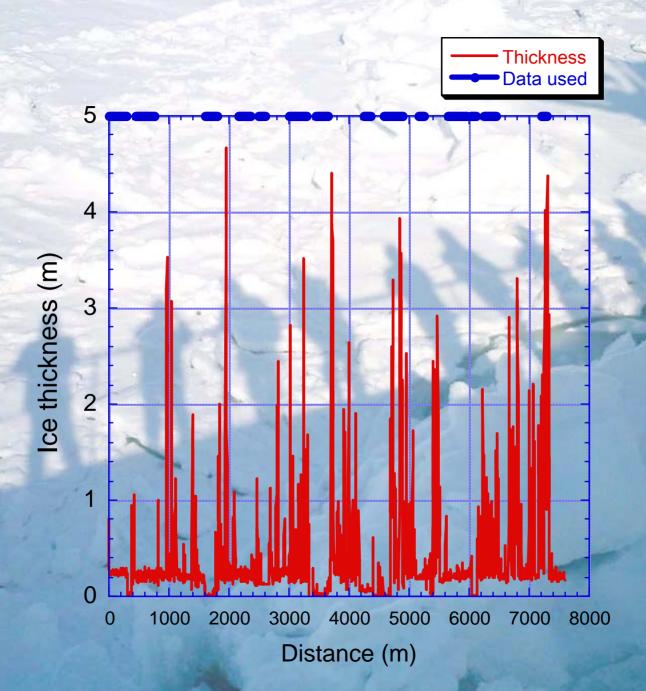


Fig. 9

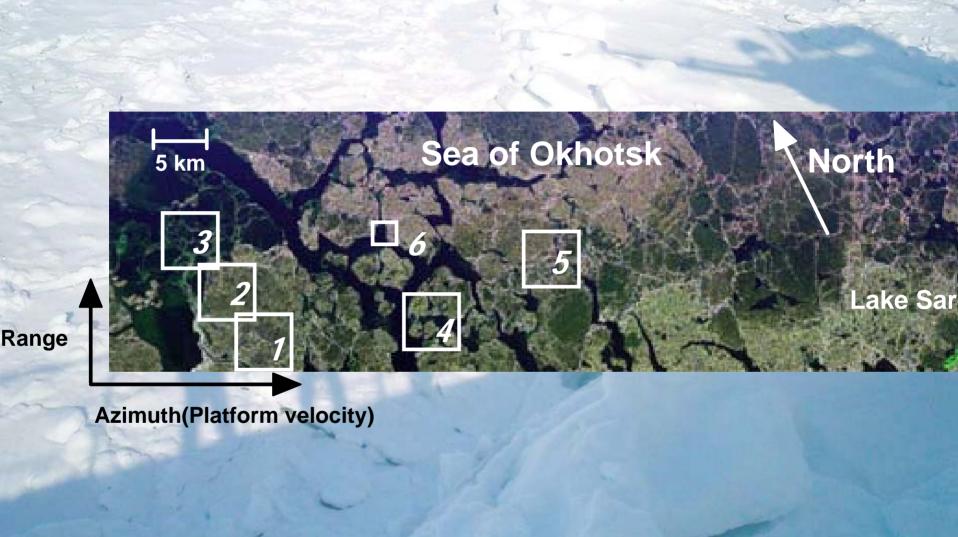


Fig. 1 (b)



Ice thickness - Backscattering coefficient

-10 Backscattering coefficient (dB) 8 -20 -30 -40 <u>-</u>- - ∨∨ -50 0.5 1.5 0 Ice thickness (m)

Ice thickness - VV to HH

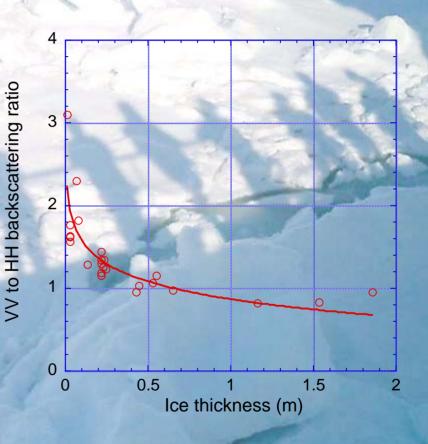


Fig. 11 (a)(b)

Ice thickness map 1.0m 2.0m

Fig. 13

Summary and Conclusions

- AMSR(X) & AMSR/E is an excellent successor to SSM/I.
- Advantages of AMSR/E includes:
- (a) More accurate ice concentration and better definition of ice edges because higher resolution and more frequency channels;
- (b) Wider swath and smaller gap around the North Pole;
- (c) Improved masking of ice free ocean; and
- (d) Improved masking of ice free land/ocean boundaries.
- Some disagreements between sensors are apparent but may be largely due to resolution differences and side lobe effects.
- Co-registered and coincident AMSR and MODIS data will provide complement and more accurate information about the ice cover AMSR(X) can be used to as the accuracy of historical passive microwave data on sea ice.
- The validation of sea ice products from satellite data is very important
- Sea ice thckness could provide the thinner thickness(<30 cm) by passive microwave data
- <u>Acive maicrowave sensor(VV/HH) may provide sea ice thickness(<ca.100cm) maps.</u>
- Sea ice thickness information & mappins could gives us the changes of ocean ice-atmosphere, related to global warming

